Repositioning of european chemicals groups and changes in innovation management : the case of the french chimical industry

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Repositioning of European Chemical Groups and Changes in Innovation Management: The Case of the French Chemical Industry

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Germany, Great Britain, and Switzerland are usually considered to be the dominant powers in the European chemical industry, since they are associated with companies of international stature such as Bayer, BASF, ICI, Ciba-Geigy and Sandoz. Founded decades ago, these firms have marked the sector dynamics with their strategies regarding academic relations, the importance of patents, diversification within a multidivisional structure, and internationalization. At first sight, France would seem to be a less important player in the European chemical industry. However, today it is ranked second in Europe, just behind Germany, and with a greater annual growth rate, as shown in the table below. The current position of the French chemical industry is a result of two simultaneous factors: a change in the relative activity of sectors, and the repositioning of companies. This paper will examine the strategies used by the four French firms that today are the major players in achieving France's unexpected success: Atofina, the chemicals division of Total-Fina-Elf; Aventis, the company formed by a merger between Hoechst Life Sciences and Rhône-Poulenc; L'Oréal; and Air Liquide.[1] The companies have differing histories with regards to the characteristics of the firm at its creation, the consequences of the oil crisis, and recent mergers and acquisitions.

Table 1: Breakdown of turnover by country in 2000 and mean annual growth rate by volume from 1990 to 2000

Country	**Turnover as % EU turnover In 2000**	**Mean growth1990 – 2000**
Germany	22.1%	2.3%
France	16.7% i.e. 82 Geuros	3.3%
Great Britain	11.3%	3%
Italy	10.6%	1.3%
Belgium	8.1%	
Spain	7.5%	
Netherlands	6.7%	

[1] The choice of these companies obviously reflects a number of assumptions about what constitutes the chemical industry. Are the pharmaceutical and cosmetics industries part of it? Does it include the oil industry? At European level, the OECD consolidates statistics regrouping sectors of activity mentioned in Table 2. The oil industry is not included, whereas pharmaceutical products and cosmetics are. In contrast, in the United States, the conventions are different; the pharmaceutical industry is separate as is the cosmetics industry while the oil industry is part of the chemical industry. We favored the European conventions, feeling it was important to use a definition consistent with the scope of most major French and European companies. The major European chemical groups have historically developed a pharmaceutical activity that is of increasing importance and has only recently become autonomous. Oil companies have developed a petrochemical activity since the 1960s, in the case of France, today these are grouped in Atofina.

Switzerland	5.4%	9.2%
Ireland	4%	
Others	7.6%	
EU	490 Geuros	3.3%

Sources CEFIC-UIC

The table below shows the change in the chemical industry over the past 25 years by presenting the respective weights of various sectors of activity in Europe and France in 2000, and the mean growth of each one over the last decade. Pharmaceutical activities and some specialty sectors (perfumes and toiletries) have grown, often at the expense of more traditional sectors of activity on which the growth of the chemical industry has historically been based since the Second World War. At the same time, companies in the sector have been transformed, first by internationalization, and then by intensive concentration and specialization.

Table 2. Breakdown by activity sector in 2000 for the European Union and France:

European Union	**% Turnover 2000**	**Growth 1990-2000**	**France**	**% Turnover 2000**	**Growth 1990-2000**
Petrochemical: plastics and polymers	29.4%	3.6%	Organic chemicals	25.6%	3.2%
Specialties: consumer-oriented products	21.6%		Parachemicals*	17%	2.3%
Agriculture	4.2%	1.1%			
Inorganic chemical	5.1%		Inorganic chemicals	7.5%	0.6%
Oleochemicals and derivatives	12.5%	1.6%	Soaps & perfumes	16%	4.5%
Pharmaceuticals	25.2%	4.9%	Pharmaceuticals	34%	4.5%

*Parachemicals include paint, glue, varnish, ink, cleaning products, cosmetics and phyto-sanitary products used directly by clients. (www.sarpindustries.fr/anglais/metier_chimie_centre2.htm)

The case of Rhône-Poulenc in France, demonstrates the first of three possible paths of development. Like other major diversified European groups, such as ICI in England, Hoechst and Bayer in Germany, Ciba-Geigy and Sandoz in Switzerland, it was directly affected by the oil crisis, then by market stagnation and a drop in commodity prices. In the 1990s, these companies engaged in specialization and concentration, leading to the creation of separate companies for pharmaceutical activities on one hand, and other chemical activities on the other. Rhône-Poulenc, a 100 -years old chemical group, was nationalized in 1982 at the time of reorganization of the industry by the government,[2] expanded its activity in the life sciences continuously from the middle of the 1980s, made its specialty chemicals sector independent by creating Rhodia in 1998, and finally merged with Hoechst Life Sciences, creating Aventis at the end of 1999.

Air Liquide and L'Oréal demonstrate a second possible trajectory. These historically specialized companies have grown continuously due to strategies of alliance,

[2] With this restructuring, two large French companies, Pechiney and Saint-Gobain, having historically developed chemical activities had to give away their assets in this sector to specialize on raw material.

internationalization, and innovation, developing uses and applications for chemical products with their customers. Today, they appear as national champions. We will examine these companies and the characteristics of their growth process.

A third path covers activities in the oil industry. In France, the role of the national government has been extremely important in the organization and development of these activities. We will examine this path based on the key events that have marked the history of the oil industry in France and that led to the formation of Atofina.

Rhône-Poulenc and the strategy of specialization and concentration

Specialization, internationalization, merger and acquisition, are the common characteristics of the three trajectories. Nonetheless, we should stress that differences are also important. Each of the trajectories explains part of the evolution in the chemical industry and is worth more detailed investigation. In this section, we describe the process that led the diversified group, Rhône-Poulenc, to reposition itself in the life sciences and finally cede its chemical activities with the creation of Rhodia.[3] To a certain extent, this evolution is the exact opposite of that of Total-Fina-Elf, which kept all its chemical activities in the petroleum group and made the pharmaceutical branch autonomous with the creation of Sanofi-Synthélabo. The trajectory of Rhône-Poulenc is interesting for several reasons. First, as stated in the introduction, many European chemical groups present diversified product portfolios similar to that of Rhône-Poulenc and have followed parallel strategies, separating chemical and pharmaceutical activities into independent companies. Second, the pharmaceutical activities in the national chemical industry figures are important and show strong growth. Determining the specific features of this activity, as spotlighted by the gradual separation process that occurred in Rhône-Poulenc, helps to explain the sector dynamics. Finally, the redefinition of the company's field of activity is recent, but so radical and irreversible that tracing the process that led to this point would seem to be a most robust analytical strategy.

Rhône-Poulenc, the mother company of Aventis, was created on a portfolio of diversified products. Its growth was driven by the development of chemical products such as synthetic fibers, and mastery of major processes to synthesize commodities. In the early 1990s, the firm was still producing a broad spectrum of products and was organized into five major sectors: fibers and polymers, major intermediates, fine chemicals, agrochemicals, and pharmaceuticals.

The history of Rhône-Poulenc is generally traced back to 1895, with the creation of the "Société Chimique des Usines du Rhône," which produced dyes and raw materials for perfumes, and the creation in 1900 of the "établissements des Frères Poulenc," which produced substances used in pharmacy and textile dye. In 1928, the two companies merged and became the "Société des usines chimiques Rhône-Poulenc." At that time, the company synthesized and marketed products with therapeutic properties, as well as products for other uses (packaging, detergents). Distribution via hardware stores, the principal network for chemical products in the first half of the century, reflected this mix of products of varied uses. From the start, the company based its growth on both chemical and pharmaceutical products. The historic factories at Saint-Fons and Vitry produced vanillin, aspirin and synthetic colorants at the

[3] The materials used as the basis for the analysis were gathered by three methods: examination of a course for project leaders (access to about one hundred ongoing projects in the company), more detailed analysis of over a dozen projects based on interviews with the project teams, and finally, a longitudinal approach monitoring a project throughout its life (two years). Charue-Duboc & Midler 94, 95, 98

former, and stovain (one of the first synthetic anesthetics) and photography products at the latter. This positioning is similar to that of other large European chemical companies.

After the Second World War, development of synthetic fibers drove the firm's growth and allowed various acquisitions. Savings from large-scale production of products, basic chemicals and innovative processes were the dominant characteristics of the firm, although its product portfolio remained diversified with fine chemicals and pharmaceuticals.

However, several years of deficit, the slowdown in the chemical sector, and the oil crisis led to the reorganization of the French chemical industry by the state in 1982. Rhône-Poulenc had to cede its activities in fertilizers and petrochemicals, and the company was nationalized. Elf Atochem (entirely owned by Elf, itself state-owned) took over several of Rhône-Poulenc's commodity assets.

Figure 2: Evolution of Rhône-Poulenc benefits as a percentage of its sales

The subsequent period was one of continued reorganization and development of more profitable activities. Acquisitions and divestitures followed one after another, and internal rationalization was also conducted. Since the mid-1980s, there has been continual reinforcement of life sciences, with the purchase of divisions of American companies, Union Carbide and RTZ in Agrochemicals, Rorer in 1986, and Fison in 1994 in pharmaceuticals. The company, which was once again profitable, was privatized in 1993.

Figure 3: Evolution of Rhône-Poulenc benefits in the 1980s

For a century, Rhône-Poulenc favored first agrochemicals, then chemicals and petrochemicals, then fibers, and then again agrochemicals and pharmaceuticals. In this way, in spite of sometimes divergent strategies and antagonisms between branches of activity, Rhône-Poulenc grew, gradually organizing its varied but synergistic activities. This heterogeneity allowed the financing of some external acquisitions (in agrochemicals for example) using cash generated by years of high profit in chemical activities. Another constant during this century of development was the important part played by external growth–-acquisitions, partnerships and other alliances–marked by periods of major reorganization and divestitures that redefined the frontiers of the company and its domain of specialization. From this history where mergers were important, two specialized companies were born: Aventis and Rhodia.

From a diversified chemical group to a European pharmaceutical company

The creation of Aventis is very recent, at the end of 1999. Rhodia, which groups the chemical activities of Rhône-Poulenc (fibers, intermediates and specialties), was created and placed on the stock exchange in 1998. Rhône-Poulenc reduced its share of Rhodia's capital to less than 28%. During this same time period, Rhône-Poulenc acquired the Health division of Hoechst, becoming Aventis. With a turnover of 21,000 million euros in 2000, Aventis, together with Novartis, has become one of the leading European pharmaceutical enterprises. Its headquarters is located in Strasbourg, and former executives of the two merged companies form the top management of this European firm.

From Rhône-Poulenc to Rhodia and Aventis: a focus on product innovation
The move towards specialties of the chemicals division and the specialization of the pharmaceuticals division

While various explanations can be offered as to why chemical activities were separated from pharmaceutical activities, this paper concentrates on management of innovation and its changes during the last twenty years. The place of innovation in company strategy is increasingly critical in the competitive business world. In Rhône-Poulenc, transformation of the project management mode in the chemicals division reveals the key place of innovation in the strategy and type of innovations. These changes accentuate the differences between the chemical and pharmaceutical branch as regards the innovation process. To understand and analyze this trend, we will distinguish three periods. The first period is characterized by company growth based on economies of scale and the preponderance of heavy chemical activities. This results in a project management model, principally dedicated to industrial production capacity construction projects. The second period was a time of transition for the group: increasing the weight of life science activities, and strategic repositioning of the chemical branch to specialty chemicals. During this period, a new project management model emerged related to the emphasis on product innovation throughout the company. Finally, the third period corresponds to the anchoring of this innovation based strategy and highlights the increasing differences between the life sciences and chemical activities.

Project management for economies of scale

The strategic context: a growth driven by "major" products

Although Rhône-Poulenc's growth was based on a group of diverse products, ranging from therapeutic and crop protection products (copper sulfate), to specialty chemicals (colorings, flavorings), intermediates (phenol) and fibers (cellulose acetate), the 1960s and 1970s saw spectacular growth in the chemicals activities. This was partly due to the remarkable development of synthetic fibers (such as nylon, polyester, and Terylene), which represented 60% of turnover by the beginning of the 1960s. It was also partly due to the crucial decision taken by Rhône-Poulenc with regard to what was then its leading product–phenol–at a time when the chemical industry was shifting to synthesizing processes using petrochemical-based material. Finally, the beginning of the 1970s was marked by acquisitions in heavy-chemical, organic-chemical and inorganic-chemical sectors with the purchase of Pechiney, Saint-Gobain and Progil (Bibard et al 95).

Project management at the beginning of the 1980s was related to the strategic model, which was an underlying factor in the growth experienced by the company up until 1975, and which was based on the production and sale of major products such as Terylene, nylon, phosphates, and phenol. In this context, projects that justified a specific management method were the construction projects for new production facilities. A typical example would be an increase in the capacity of a phenol factory, which represented an investment of several hundred million francs: the product is known, as is the process. The project is restricted to the construction of a production unit. A process, which has been outlined on paper or tested on a laboratory pilot, is developed into a full-scale industrial unit. The project involves finalizing process engineering studies in order to define the unit in detail, signing supply contracts, optimizing the installation of the main machinery and pipe-work, coordinating the construction site, and providing an interface with the host site.

Characteristics of the project management model

The organization and method of undertaking projects, drawn up in the 1980s, were similar to those for large building sites (engineering model, Midler 96). The client would

stipulate their requirements with regard to the production facility (volumes, unitary cost, product quality, time-scale of start-up) and the prime contractor—the construction project manager—would coordinate the various means necessary to construct the facility that had been ordered. It would be the construction project manager who would organize site managers, instrumentation experts, purchasers, and draftspeople from the design office, and others. Such project organization is particularly appropriate to Rhône-Poulenc's matrix structure, which involves a partitioning of responsibilities according to activity or product group, and a hierarchical organization within each activity, particularly in engineering. The client belongs to the product structure, and is often the industrial director of the "enterprise" (strategic business unit). The main contractor is from engineering. The quasi-commercial relationship between these two is borne out by an internal contract similar to that between a client and a supplier.

Chart 1: Rhône Poulenc organization ; a matrix structure

The development of this type of project organization can be explained by the specific characteristics of the projects to be carried out; i.e. size of the budgets, large numbers of people to be managed, and numerous suppliers. In such projects, the main uncertainty relates to time-scale and costs, two aspects brought under control by project monitoring tools. The planning tool makes it possible to plan the project's time frame and to coordinate the various actions, as well as to spot actual delays and anticipate their consequences. Expenditure control and the early identification of discrepancies are facilitated by generic profiles of planned expenditure according to the project's progression. On such questions as duration and cost, a great deal of experience has been capitalized across projects in the engineering department.

The rise of the life sciences sector and an emphasis on innovation management

Evolution following the 1982 restructurings

Following the restructuring of the chemical industry by the State in 1982 and the nationalization of Rhône-Poulenc, steps taken during the 1980s to enable the group's recovery later redefined the company. A number of divestitures were made in the textile, heavy chemical and petrochemical areas (Lane S.J.). Some were decided during the reorganization conducted by the French government, while others were concluded directly with private companies. However, the second half of the 1980s was marked by acquisitions in agrochemicals (the agrochemical division of Union Carbide in 1986), pharmaceuticals (Pasteur vaccines, Connaught, Virogenetics, Rorer in 1990) and specialties (RTZ). Thus, between 1986 and 1991, 40 billion French francs were invested in acquisitions. These acquisitions had also a significant role in the internationalization of the French group.

In the early 1990s, cyclical effects within the chemical industry again challenged the strategy of mass economy and economies of scale. Manufacturing over-capacity and economic under-performance in the downstream sectors, together with an increase in production costs resulted in a drop in world prices for standardized products. Competition from countries with cheap labor also proved to have a particularly negative impact on this type of strategy.

Figure 4 : Rhône-Poulenc operating margin by sector

The agrochemical division, with the acquisition of the agrochemical division of Union Carbide, saw its turnover rise from 6.5 billion francs in 1986, to 10.5 in 1989, while the operational margin increased from 7.9% to 11.4% over the same period. At the beginning of the 1990s, the agrochemical and pharmaceutical activities already represented 48% of the turnover

in 1991, while in the 1960s, the chemicals division and fibers represented 80% of turnover. These numbers can serve as a reference for fixing objectives for other sectors: 15% of operational margin with regard to turnover. The company was cited for its exemplary innovation strategy, and its capacity–-thanks to the production and marketing of innovative products-–to maintain high margins. The sectors in the life sciences came to exemplify the new models of economic excellence. Jean René Fourtou, CEO of Rhône-Poulenc from 1986 to 2002 probably had that vision early on and led the group to Rhodia and Aventis.

Figure 5: Rhône-Poulenc sales by sector of activity

Search for synergies; innovation management as means of integration

Following this period of divestitures and acquisition, the 1990s saw a focus on the internal organization of the different sectors of activity in order to consolidate their positions, bring together teams with differing histories from various backgrounds, and gain maximum benefit from the synergies between these recently united entities. Amid the internal rationalization at the beginning of the 1990s, an initiative was launched relating to innovation project management. In the 1990s, project management was a managerial fashion that came from the automobile industry (Clark and Fujimoto 91, Midler 93). It was hardly surprising that Rhône-Poulenc headquarters noted its importance for the company, since it was being implemented in several industrial sectors. Project management requires integration between services and the various specialty areas, and also relates to the company's internal team management.

From 1992 onwards, innovation project management was referred to in communications from the general management as one of the five key areas to be developed. The aim was to provide the best possible prospects for growth while at the same time achieving double-figure margin levels in terms of percentage of turnover. It therefore played a pivotal role as far as the company's competitive position was concerned, and affected all of the group's business activities and sectors.

Innovation project management at Rhône-Poulenc began initially with a benchmarking initiative between the various divisions. At the beginning of the 1990s there were five such divisions: organic and inorganic intermediates, specialty chemicals, fibers and polymers, agrochemicals, and health. This type of approach demonstrated a desire to draw upon the group's diversity and to exchange the techniques and expertise developed in the various divisions in order to capitalize on, unite and improve project management in each of the divisions. R&D managers from the various divisions formed a working group for exchanging their various related experiences, which operated for one year. The end result was a white paper on project management setting out best practices, which was in fact a list of recommendations. The white paper also included a self-assessment guide, designed to help each sector identify any necessary action for improvement. Two points need to be emphasized. The first is that the life science activities, where several major innovative products were being developed, rapidly proved to be the model to follow. At management level, the project management initiative was led by the former agrochemicals director. The second is that, at a time when operational management was being decentralized, it quickly became clear that there was a need to develop a project management "doctrine" for each division. The second stage was then to ask each division to put forward action plans, with a view to improving the implementation of project innovation.

Strategic redirection towards chemical specialties and emergence of a new project management model

Innovation projects in the chemical division

For the chemical division, implementing a strategy similar to that of the life sciences division meant exploring a greater variety of products and their properties, instead of being mainly geared towards developing new synthesizing processes for products that were already well known. Since in the 1980s the division had concentrated on major products and on economies of scale, innovation was confined to improving processes, and development of innovative products was not at the forefront. The chemicals division began structuring the development of innovative products/services/processes referred to as "innovation projects" in the white paper. Greater emphasis was placed on product innovation. Innovation projects were set to develop specialty products (pigments, solvent-free paints, additives for recycling and so on) for niche markets. Basic products were reworked in order to achieve the properties required for specific applications (silica for tires, phosphates for the treatment of salmonella). These projects marked a change from a strategy based on major standardized products to a strategy of offering innovative products that had been optimized for specific uses (Cohendet, et al. 84, 89; Colombo, 80). This emphasis on innovation project was both a sign and an integral part of the strategic redirection towards specialty chemicals that the chemicals division had taken. This decision was, no doubt, based on a comparison with the life sciences sectors. This redirection led to a progressive yet profound change in the style of project management. A new method of project management emerged that was significantly different from what had been previously used (as described above). The project scope changed: research activities (exploring the technical characteristics of a new product and conditions for synthesis), marketing activities, an understanding of product use, market analysis and industrialization were incorporated into a unified and integrated project. Projects were no longer limited to the phase of industrializing a process and building a unit. A multidisciplinary team was created. A project manager was dedicated to the project for its whole course. He was in charge of the overall success of the project. This project organization had many similarities with the heavyweight project management model (Clark and Wheelwright 92, Midler, 93).

Some specificities of innovation project management

Concurrent engineering (Navarre 93) was developed as the result of various factors: there was an overall project responsibility; the project scope incorporated the various aspects; shortening the time-to-market for new products was very important from a competitive point of view; and uncertainty was very high. Uncertainty lay with the process, as well as with the suitability of the product vis-à-vis the clients' uses, its acceptability, and with comprehension of its most sought-after properties, and therefore those most capable of generating value for the product and, potentially, profit. Managing uncertainty required the ability to integrate new information at any step of the project and to react quickly because of the virtual impossibility of foreseeing properly on all these dimensions. A client analysis approach was adopted to study product usage and the various processing intermediaries up until the product reached the end user. Expertise within the firm had to be developed with regard to product properties for the processor, on the one hand, and with regard to the transformation processes, and particularly required properties, on the other. Application laboratories and applicability teams were set up. Application laboratories studied the end-use properties of the finished product in the composition of which the chemical product was used. For example, the anti-foam properties of a silicone to be used in the composition of a washing powder would be measured and characterized. The role of applicability laboratories was to establish correlations between

physico-chemical properties of molecules and their application properties. Such understandings were key at the product development stage in order to direct the development process and to fine-tune marketing strategies.

The relationship with clients was also transformed; from price and volume negotiations for a given quality, partnerships began to develop with clients to explore jointly the properties of the product under development and decide which one was the more valuable for the consumer. This trend of development of win-win partnership is similar to that described in the automotive industry (Garel Kesseler 98) between the car manufacturer and their main suppliers. The chemicals division therefore underwent a series of fundamental transformations:

--transformation as far as product strategies were concerned, from standardized products sold for their physico-chemical specifications to diversified products targeted in relation to the client for their properties in specific applications;

--transformation as far as the methods of innovation and project management were concerned, leading to the development of a closer relationship between researchers and markets, and the establishment of integrated teams (research, process, marketing), whereas in the past these had been sequential and compartmentalized;

--transformation with regard to external relations leading to the establishment of development partnerships based on complementing the expertise of each of the partners, and not on direct pursuit of external growth.

Figure 6: Comparative evolution of Rhône-Poulenc and Rhodia during the 1990s

This transformation took several years: in 1991-92 the need for a strategic repositioning was identified; in 1995 the specialty and raw chemicals branches merged; and in 1998 Rhodia was created and progressively separated from the rest of Rhône-Poulenc.

For such a strategic evolution to be successful, several learning processes needed to occur. These learning processes had to take place at different levels and in various areas of the organization. New skills had to be built within the application and applicability labs; new relationships had to be set up with clients based on a larger market knowledge and better understanding of the client constraints and stakes; new project management methods had to be implemented involving the learning of new behavior such as working and coordinating actors under uncertainty; and lastly, the company had to learn how to select projects in a portfolio in order to balance different kinds of risk and different timing. Today, the results of this new strategy still appear fragile, as can be seen in the graph below. The evolution, however, is irreversible because of the divestiture undertaken in the commodities. Learning processes have already developed but remain to be completed. The challenge for the company is to reinforce its position as an innovative company that can survive “bad” years (currency exchange rate, economic cycles) with reduced benefits but no deficits. This innovative dynamic has already proven fruitful with 14% of new products contributing to the group sales and an increase in the group’s market share in eight strategic markets. Nevertheless, today, debt related to previous deficits and acquisition is negatively impacting the results. In addition, bad economic conditions have slowed learning processes because cost cuts often strongly affect R and D expenses, and, as a consequence, new product development.

This fundamental transformation, in which the life sciences sector was to have such an instigative and referential role, might have brought the sectors closer together. In fact, to a

certain extent, that came about as a result of the replication of the same strategic model, thus leaving the way open for product innovation. The aim was to establish competitive ranking by introducing new products, which improved on existing products, and to optimize profitability by adding value to the client system. Contrary to the premise that the chemicals division would imitate the strategic model of the life sciences division, it would seem that the chemicals division's strategic redirection actually intensified differences. It could even be said that these differences were more limited when the chemicals division followed a strategy of economies of scale, and that they paradoxically became more pronounced after the strategic move towards a competitive model through innovation.

Innovation processes: differences between pharmaceuticals and chemicals

In the preceding sections, emphasis has been placed on the manner in which project management was transformed in the chemicals division. Indeed, it was in this division that the changes were the most spectacular. In the pharmaceutical sector, innovation projects were also introduced, but these projects have distinctive characteristics that determine the way they are managed. Consequently, innovation projects actually increased differences compared to what had come before.

The first distinctive characteristic relates to the regulatory requirements, which have become increasingly stringent. Any new drug or agrochemical must undergo an extremely detailed examination by regulatory authorities before receiving the authorization to be introduced on the market. The approval dossiers must show the effectiveness of a new product, as well as demonstrate its safety (i.e. for the environment and patient health). The dossiers contain the results of numerous tests; they describe the product and the manufacturing process in great detail.

The second characteristic is the importance of patents. As in any industry, patents protect companies that have incurred heavy research and development costs from competitors, who would otherwise simply need to develop a production process for a product that had already been approved. In the drug industry, the patent system is further strengthened since public health authorities will grant market authorization if a therapeutic benefit can be shown over existing products. As this benefit increases, so does the price the public health authority will allow. It is therefore very important to be the first to file for a patent. In addition, the major companies tend to focus on a few potential flagship products and on exploring the same therapeutic targets or the same crops. As a result there is a veritable race to apply for patents. These two specificities have had important implications on the evolution of innovation processes in the pharmaceutical industry.

Pharmaceutical and agrochemical groups have tended to concentrate their research and development efforts on products that are likely to generate a high turnover, so as to compensate for the development costs. In the past decade, the amount of study required for the approval of a product has continuously increased and development costs have become extremely high. Companies are thus focusing on high-volume products that are often marketed on a worldwide scale, and/or products with high added value, often corresponding to therapeutic or preventive products that previously did not exist. Niche products are not viable in terms of development costs, given the narrow market targeted. Isolated or breakthrough innovation strategies (Tushman & Anderson 86) are followed and enabled by patent protection. On the contrary, repeated innovation strategies as observed in the appliances (Chapel 97) and IT industries (Brown & Eisenhardt 97) are not required to stay ahead of the competition.

Within the development process, concurrent engineering is almost impossible because of regulatory requirements. Efficacy tests are not allowed unless safety tests have proved conclusive. Efficacy tests must be carried out on a synthesized product according to an established manufacturing process. For any new product development, the major issue at stake is obtaining approval. But the regulatory authorities may quite easily delay market entry by requiring additional tests. Such a delay would leave the way open for a competitor with a completed approval dossier to be the first on the market. Thus, any late modification to the process or the product that might optimize its efficiency and the global profitability of the project is regarded very carefully as at risk for not getting the authorization on time and having to undertake additional tests. We can say that development planning is governed by this regulatory system.

Pharmaceutical companies prepare the ground for patent application at the earliest possible opportunity. The protection of intellectual property is no longer just a defensive strategy: it can also be seen as an offensive strategy, by using patents to protect a wide field, thus limiting competitors' ability to explore promising avenues. Greater co-operation with public research establishments is developed because of the importance of patents. Early identification of the most promising new avenues can lead to a speedy investigation of potential drugs. The approval process also gives an ever-greater importance to relationship with the public research center. Scientific recognition of the company research labs by the research community and regulatory authority add to the credibility of the approval dossier. This provides an additional opportunity for closer relationships between industrial and public research centers through conferences, publications, research partnerships, and recruitment.

Because of regulatory authorities' requirements for approval, concurrent engineering is very limited, even though time constraints as regards competition for patenting and approval are important. Within this context of increased development costs the focus is more and more on "big products" to be sold on a worldwide basis and niche strategies are not attractive from an economic point of view. Because the patent system gives such an advantage to the first on the market, alliances, partnerships and mergers are increasing. This trend for pharmaceutical groups to join forces is also designed to provide companies with sufficient financial means to engage in increasingly costly development programs. By choosing alliances or partnerships with companies focused on the same therapeutic targets and on molecular compounds, groups are ensured access to the global market and to the most promising areas of new development. Development partnerships are also set up with research laboratories upstream. The most important ones are definitely not with client downstream or for issues concerning the chemical process.

Affirmation of divergence in product innovation strategy

In the current context, the common competence on which the chemical and pharmaceutical branches were based-–competence in chemical processes and their industrialization-–seems only to be of secondary importance. The competences involving the products and their properties and an understanding of the mechanisms that underlie their efficacy have become key elements. The development of these competences draws the chemical and pharmaceutical branches in opposite directions.

The chemical branch has moved away from standardized products manufactured in large quantities to concentrate on diversification in specialty products with high margins. Niche and specialty strategies have therefore been developed. In this type of strategy, patents offer less protection from competition. Indeed, different products may have quite similar properties.

Competition by innovation therefore implies that new innovations be brought onto the market at regular intervals. This is the strategic model of repeated innovation (Hatchuel *et al*. 98). Short development time is a condition of the competitiveness of this strategy. The firm must be quick to offer a ”me-too” product, or to respond to identified client expectation. Project organization must allow for concurrent engineering. Implementing this specialty strategy requires an understanding of client expectation, the transformation processes they employ, the properties they require and how they are measured. Client partnerships, and even alliances, have been set up. The importance of application and applicability laboratories has also increased.

In contrast to the chemical branch where downstream development partnerships with customers have been developed, in the health sector upstream partnerships with academic research centers have been set up. Their goal is to improve understanding of the mechanism of action of medicinal drugs, with a view to registration and patents. In the chemical branch, highly integrated development processes have been instituted. Concurrent engineering was privileged to reduce development delays as far as possible and test products on customers. In the health sector, on the other hand, processes are highly sequential given the regulatory constraints, each project targets a major market and a product with a long lifespan, conditions needed to offset development costs. In all, it can be said that if innovation is crucial to both branches of activity, it nonetheless presents virtually opposite characteristics for each. Each branch has adopted an innovation strategy consistent with its characteristics. The chemicals division has turned to a repeated innovation strategy while the pharmaceutical branch tries to protect its position building barriers to entry that are as durable as possible.

Companies downstream in the industry and customer oriented

Air Liquide and L’Oréal were created almost a century ago with private capital to target niche markets. It is only very recently, at the end of the 1990s, that these companies joined the leaders in the sector. We will try to stress a few outstanding features of their growth strategy using a macroscopic view.

Air Liquide, today, is number one worldwide in industrial gases, with a turnover of 8,100 million euros in 2000. One-third of its sales are made in the US, half in Europe, and 15% in Asia Pacific. The company was created in 1902 by a chemist, Georges Claude, who had developed an acetylene liquefaction process and a process to separate and liquefy oxygen and nitrogen in the air. Innovation, patents and international development have been characteristics of the company since its creation. As early as 1906, the company acquired installations in Belgium and Brazil. In 1907, a patent for neon tubes was obtained.

After a period of growth, the 1960s saw a reduction in demand. Air Liquide then decided to specialize in the industrial gas market. Targeted acquisitions allowed it to extend its customer base. In 1969, the firm developed its activities in the United States. In 1986, Air Liquide held 14% of the American market, and with the purchase of Big Three Industry, became the second most important producer of industrial gas in the United States.

Specialization, innovation, and internationalization were virtually continual growth vectors. Innovation allowed the company to reinforce its competitive position and to adapt to changes in the market. When the market for oxygen (for the steel industry) and acetylene (welding) declined, new products were developed for the electronics and food sectors (certain inert gases improve food conservation).

Finally, since its creation the company has needed to raise capital and has distributed dividends. Today it is still a private company quoted on the Paris stock exchange. The net profit in 2000 was 8% of turnover.

L'Oréal is the world cosmetics leader with a turnover in 2000 of 12,671 million euros, and sales in Europe (51%), the USA (30%) and other countries (19%). The company traces its history back to the chemist, Eugène Schueller. Having developed a colorant manufacturing process, he developed a market for hair dyes. An eccentric visionary, in 1907 he proposed his product to hairdressers and created the *Société des Teintures Inoffensives pour Cheveux* (Society of Dyes Safe for Hair) in 1909.

The company's strategy of diversification started in 1928 with the purchase of Monsavon. In 1933, a shampoo for the general public – Dop – was launched. In 1936, a sun cream was marketed for the first paid holidays granted by the Popular Front government. From this time on, the company has been remarkable for its publicity strategy using all possible media and designs by the best artists.

The 1960s and 1970s were marked by a diversification in distribution methods. Hair products reserved for professionals (dyes, hairsprays) were introduced onto the public market. Several acquisitions in perfumes, beauty creams and cosmetics gave access to the perfume distribution network. In 2000, the company was organized into four branches: professionals (hairdressers), the general public (skin and hair care, cosmetics), luxury (cosmetics and perfumes), and active cosmetics (skin care). Sales were 55% on the public market, 27% in perfume shops, 12% to hairdressers and 5% for skin care.

Finally, international development started long ago. In 1953, L'Oréal sold its products in the United States via Cosmair. In 1994, L'Oréal acquired control of Cosmair, which in 2000 became L'Oréal USA. Multiple modes of distribution, an original publicity strategy, and early international development have always been characteristics of the company.

Although it is positioned in general public products, L'Oréal has always based its new products on technical innovations. Research and patents have played a key part in the company's development. Hence, when L'Oréal decided to develop anti-aging creams at the end of the 1950s, the company formed a research team specializing in these areas. In 1973, L'Oréal even invested large sums in the pharmaceutical sector with the acquisition of 53% of Synthélabo. However, this majority investment did not lead to integration of the companies' activities. Today, L'Oréal holds 20% of Sanofi-Synthélabo, an autonomous company in the pharmaceutical sector.

Still in private hands, the company's capital was entirely held by the family until 1963. At that time, Eugène Schueller's daughter, Lilliane de Bettencourt, sold part of the shares. In 1974, a second batch was sold, and the Swiss group, Nestlé, became one of the shareholders. Today, 54% of the group is owned by a holding company, Gesparal, of which 51% is held by L. de Bettencourt and 49% by Nestlé.

With similar starting points, Air Liquide and L'Oréal occupy very different market sectors. Air Liquide specializes in services to industrial companies, and customized services with a strong technical component. L'Oréal has developed innovative products for the general public and supported their development with sophisticated research and marketing actions. The two companies have had similar growth processes: created by chemists through mastery of novel chemical processes, relatively unconnected to oil chemicals, they stressed development of their

competence in their products/services and anticipated customer needs. Growth and internationalization are based on alliances and targeted acquisitions, the most fruitful of these today date back to the 1960s.

The Creation of Total-Fina-Elf

Turning to oil exploitation, the growth of a chemical branch in oil companies, and the role of the government in France, we find that Total-Fina-Elf was created following Total's acquisition of the Belgian company, Petrofina, in 1998, and the long state-owned and recently privatized French company, Elf Aquitaine, in 1999. Turnover in 2000 was 114 billion euros. It is the fourth largest petroleum group worldwide. Sales are split between Europe (54%, with only 31% in France), North America (9%), Africa (4%) and the rest of the world (33%). Atofina was created in April 2000 to consolidate the petrochemical activities of the three companies, and is wholly owned by the oil group. Turnover in 2001 was 19.6 billion euros, with 38% for commodity polymers, 25% for performance polymers, and 36% for specialties. The markets are divided, with 63% in Europe, 27% in North America, and 10% in the rest of the world.

The history of Total-Fina-Elf is very different from that of Air Liquide or L'Oréal. The company was created around a raw material, and growth in chemicals was a consequence of positions upstream in the industry. It is much more recent. Describing the origin of the company means going back to the creation of its three components: Total, Fina, and Elf. All three were created to exploit petroleum, and national interests were critical in the creation of Total and Elf. Governmental involvement in the strategy of these companies was important, as shown by their capital holdings.

Elf resulted from the consolidation of three entities whose capital was entirely held by the French government: the RAP (Autonomous Petrol Board) created in 1939, the SNPA (National Society for Aquitaine Oils) in 1941, and the BRP (Oil Research Bureau) in 1945. The aim of these three "companies" was to explore and exploit oil and gas resources in France and its colonies. The politicians' goal was to make France independent in energy.

The CFP (French Petroleum Company), which became Total, was created in 1924 to develop a petrol industry in France. The involvement of the French government was considerable here, too, providing 25% of the capital on creation, and 35% from 1931. Each of these companies based its development on exploitation of oil resources, refining and distributing fuel. Elf used the gas resources in Lacq in southwestern France, and then Algeria. Total historically developed from the oil fields in Turkey and Iraq.

Petrofina was created in 1920. Belgian financial groups took over Rumanian oil exploitation installations taken from the Germans during the First World War. These Soviet oil fields, and then American fields in Texas, were exploited before the discovery of North Sea oil.

The diversification of these companies into the chemical industry occurred during a second phase. The development of chemicals in Total occurred conjointly with Elf with the creation in 1971 of Atochimie and Chloé (chlorine and ethylene) in 1980. In 1981, the development of Elf in the United States was boosted by the acquisition of Texas Gulf, which added very significant industrial holdings in phosphates and fertilizers. However, the place of Elf in the chemical industry is linked to French industrial policy in the years 1970–1980. The oil crisis in the 1970s led to disastrous results for chemical companies confronted with an increase in the price of raw materials and a reduction in the price of chemical products related to overcapacity, internationalization of markets and low growth of downstream consumers of

chemical products who were also affected by the oil crisis. The French government then decided to reorganize the chemical industry by redistributing assets between companies and nationalizing Rhône-Poulenc. The industrial policy was intended to limit competition between French firms at the national level, and to form large companies capable of competing with their rivals at international level. In 1983, Atochem was created. This company is wholly owned by Elf, which is itself entirely owned by the State. Atochem regroups the industrial assets of Rhône-Poulenc in chlorine and ethylene derivatives, those of Ugine Kuhlman in chlorine and fluorine derivatives, and in phosphates. Atochem then organized its activities into three product lines: bulk products for plastic and chemical materials (ethylene, propylene, benzene styrene), plastics and technical polymers and specialties with chlorinated, fluorinated and sulphur products. In 1990, Atochem took another step, acquiring Orkem, the chemical division of Charbonnages de France.

For Fina, diversification in chemicals goes back to the early 1960s, with investment in Petrochim (54) and development in the production of ethylene, polyethylene, paint polymers (63), and then styrene and polystyrene. At much the same time, Fina positioned itself in the soap segment with Oléochim (1957). In 1972, Sigma Coatings was created, grouping together Fina's paint interests. In 1998, Sigma Coating incorporated the activities of Lafarge in paints, and is now the third ranked company in Europe in the paint domain. Fina holds 80% of the company, and Lafarge, one of the largest French building companies, the remaining 20%. In 1983, Fina was one of the major European producers of high-density polyethylene. In 1998, agreements were concluded with the Belgian company, Solvay, to double the production capacity in the next ten years.

The French government did play an important role, but has been withdrawing since the mid-1990s. First, there was a reduction in direct participation in the capital of Total in 1992 from 31.7% to 5.4%, then in 1996 to 0.97%. Elf was privatized in 1996. These changes in the structure of the capital opened the way to the concentration seen afterwards. Total-Fina-Elf is a private company quoted on the Paris and New York stock exchanges with 13% of stable shareholders.

Atofina is, today, divided into three branches: petrochemicals and commodity polymers (polyethylene, polypropylene, styrenes, PVC, and others), intermediates and performance polymers (chlorine, fluorine, oxygen derivatives, functional polymers, etc.) and specialties (such as paint, adhesives, and rubber). Commodity polymers account for 38%, performance polymers for 25%, and specialties for 36% of activity.

Sanofi-Synthélabo

Similar to the creation of Atochem in 1973, Sanofi was created by merging several French pharmaceutical companies to form a company of international stature. Initially, the firm was entirely held by Elf. However, in 1979, the capital was opened up, with Elf keeping the majority. The company grew by multiple alliances, notably with Japanese companies. The merger with Synthélabo in 1999 accounts for its current stature. It is the second [largest] French pharmaceutical company and the seventh in Europe, with a turnover of 7,508 million euros in 2000. The reference shareholders are Total-Fina-Elf (33%) and L'Oréal (20%) in 2000.

Conclusion

Since the Second World War, the chemical industry has gone through several evolutions. Our analysis has specifically focused on the period covering the last 25 years of the

20th century. During this period, the French chemical industry, which has historically based its growth on the mastering of high-volume production processes of well-known chemicals, progressively changed its position. Growth was increasingly driven by the use of chemicals in various applications: specialty goods with high value added, diversified products dedicated to end-users (in the cosmetics for example) and pharmaceuticals. This evolution can also be traced in society at large: health expenditure have been continuously growing, consumers are looking for personalized and frequently renewed goods. The demand for these products is as much a result of the strategies of the companies as an opportunity they have taken. The place of the French chemical industry today is a result of the strategy that the main companies have deployed to face this global evolution.

In the area of specialty goods, two typical trajectories can be characterized. The first is the continuous growth of companies focused from their creation on a type of specialized products, having developed relationships with their customer, gained market knowledge, structured new product development and proactively offered new products to their customer. Air Liquide and L'Oréal exemplify this strategy. These companies were founded on the mastering of a chemical process, but the exploration and invention of new usages for their products and of products with new use value for their customers propelled their rapid growth. Air Liquide has diversified the use of industrial gases from traditional customer to electronics and food industry for example. L'Oréal has expanded its product portfolio from toilet products to cosmetics and skin care.

The second trajectory is the strategic repositioning of diversified chemical groups that have based their growth on commodities and economies of scale and have recently focused their activity on specialty products instead. We have analyzed this strategic change using the case of Rhône-Poulenc and its chemical division. We have underlined the impact of this evolution on the organization of product development: coordination between researchers, process engineers and marketing people, development of new technical knowledge, new relationships with customers. This evolution led to a new firm: Rhodia.

Historically intertwined with the chemical industry in France, the pharmaceutical branches of large companies have become autonomous and specialized in pharmaceuticals as a result of acquisitions and concentration of pharmaceutical activities to gain a critical size. This evolution has taken place in France as well as in other European countries in the last decade. The case of Rhône-Poulenc and its transformation into Aventis is typical of this trend. The specific nature of the regulatory system and the patenting regime as well as the necessity of commercializing products on a worldwide basis have induced concentration and specialization in this sector. So despite their common focus on innovation, the pharmaceutical and chemical division evolved in diverging direction as far as scientific and industrial partnerships are concerned.

The production of commodities has remained an important component of the chemical industry. Globalization and merger and acquisition have characterized the recent period in this activity also. In France, only companies having assets in oil exploitation have been able to remain competitive in raw chemicals. The intervention of the French government, which has been massive at different point in time in the past but which has today become more and more limited, is still imprinted on Total-Fina-Elf. The French government was part of the origin of Elf and Total because of the importance of oil for industrial development and economic independence. The state as the prime shareholder (indeed, the only one for Elf until the mid 1990s) has long taken part in the strategic decisions of these companies. The restructuring undertaken by the French government after the oil crisis in 1982 has led to the division of assets

in the raw chemicals between Elf Atochem (created as a subsidiary of Elf totally owned by the company) and Rhône-Poulenc which was nationalized. Today, there is no more state-owned company in this industry. This evolution of the French state from a “hands on” to a “hands off” position was a precondition to the mergers that occurred in the late 1990s. It had led to a dramatic change of the industrial policy in this sector in France.

Figure 1

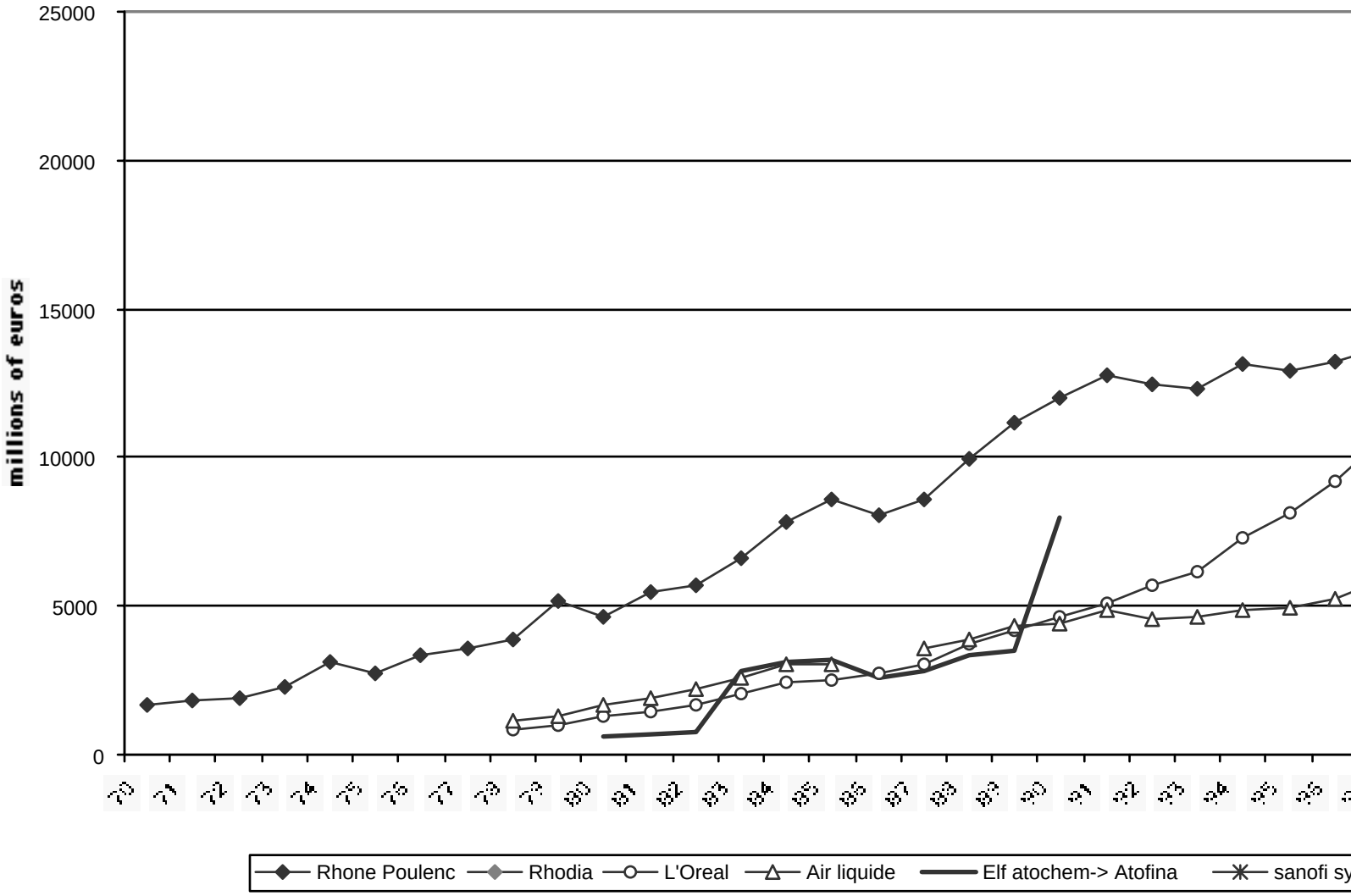
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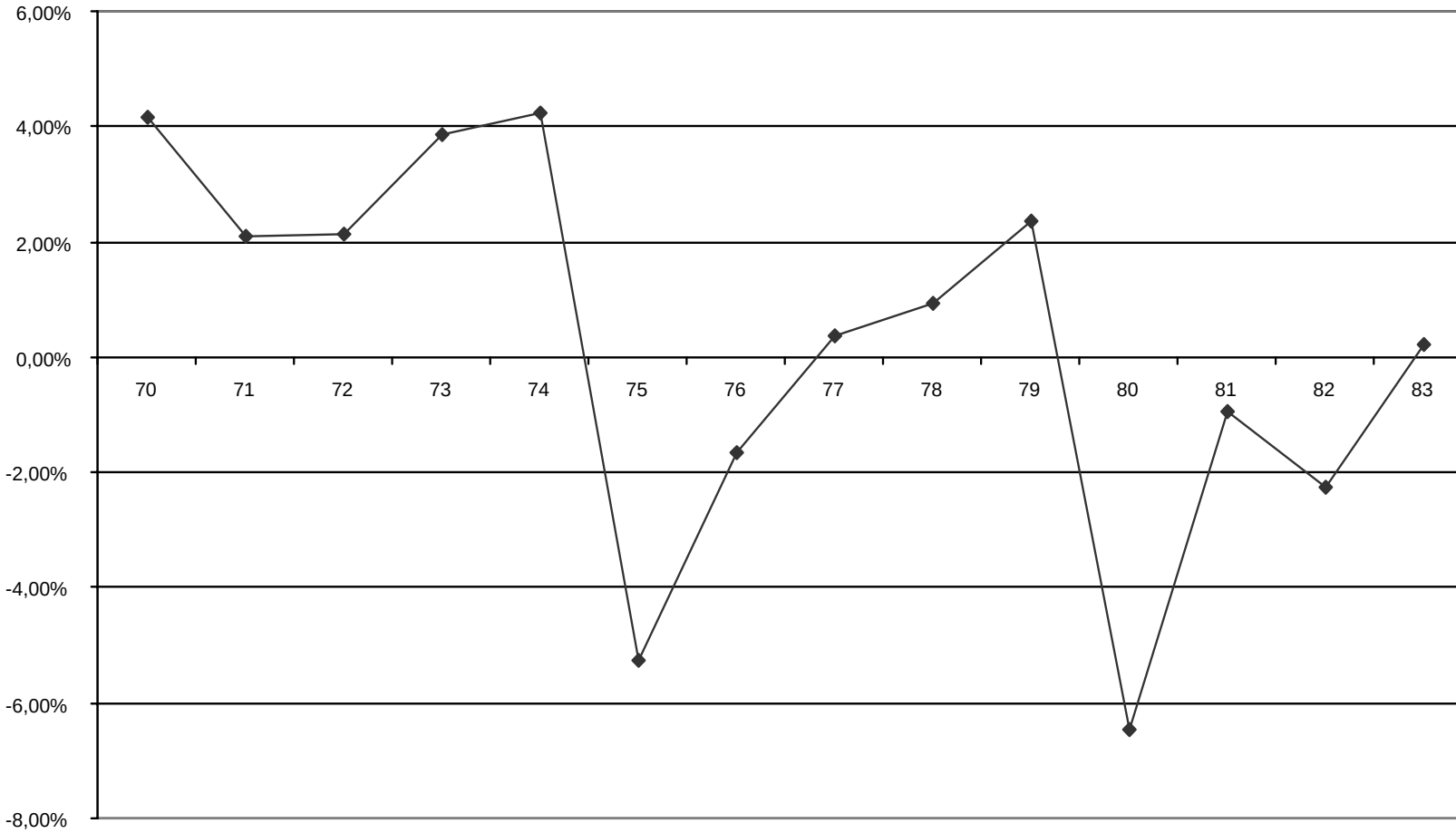
Figure 2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A matrix type organization

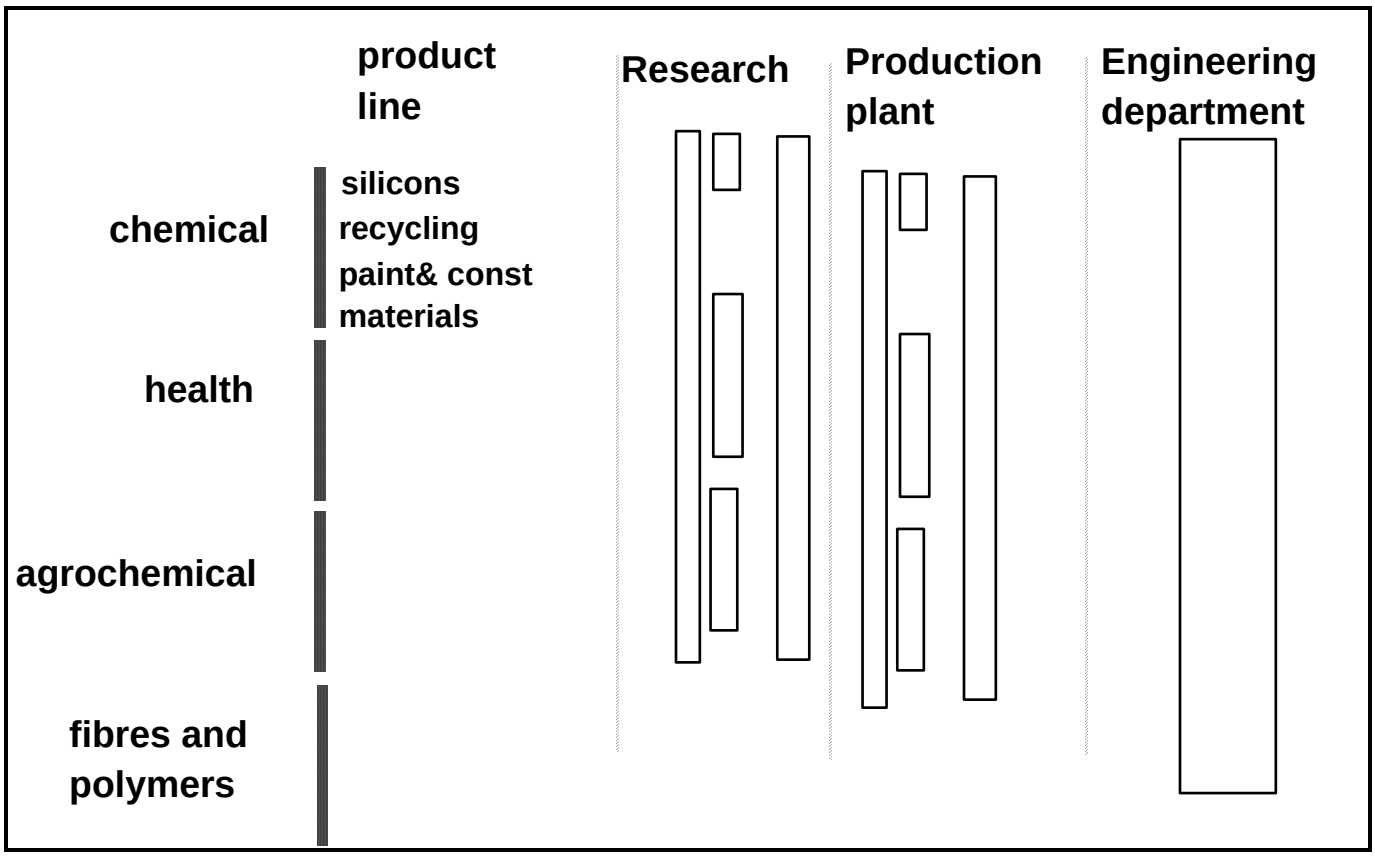

Chart 1: Rhône Poulenc organization ; a matrix structure

Figure 4

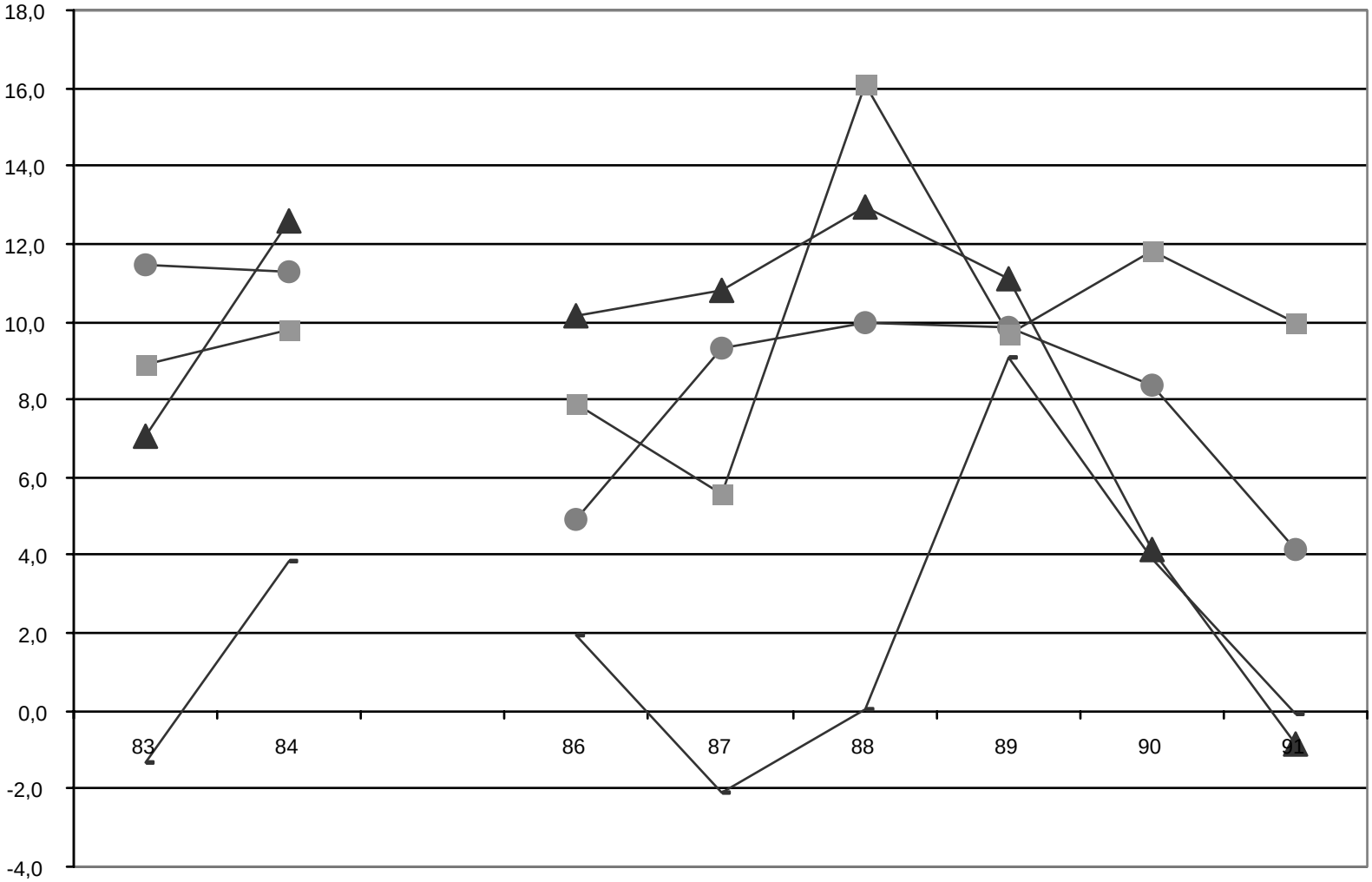

Figure 4 : Rhône-Poulenc operating margin by sector in the 1980s

Figure 5

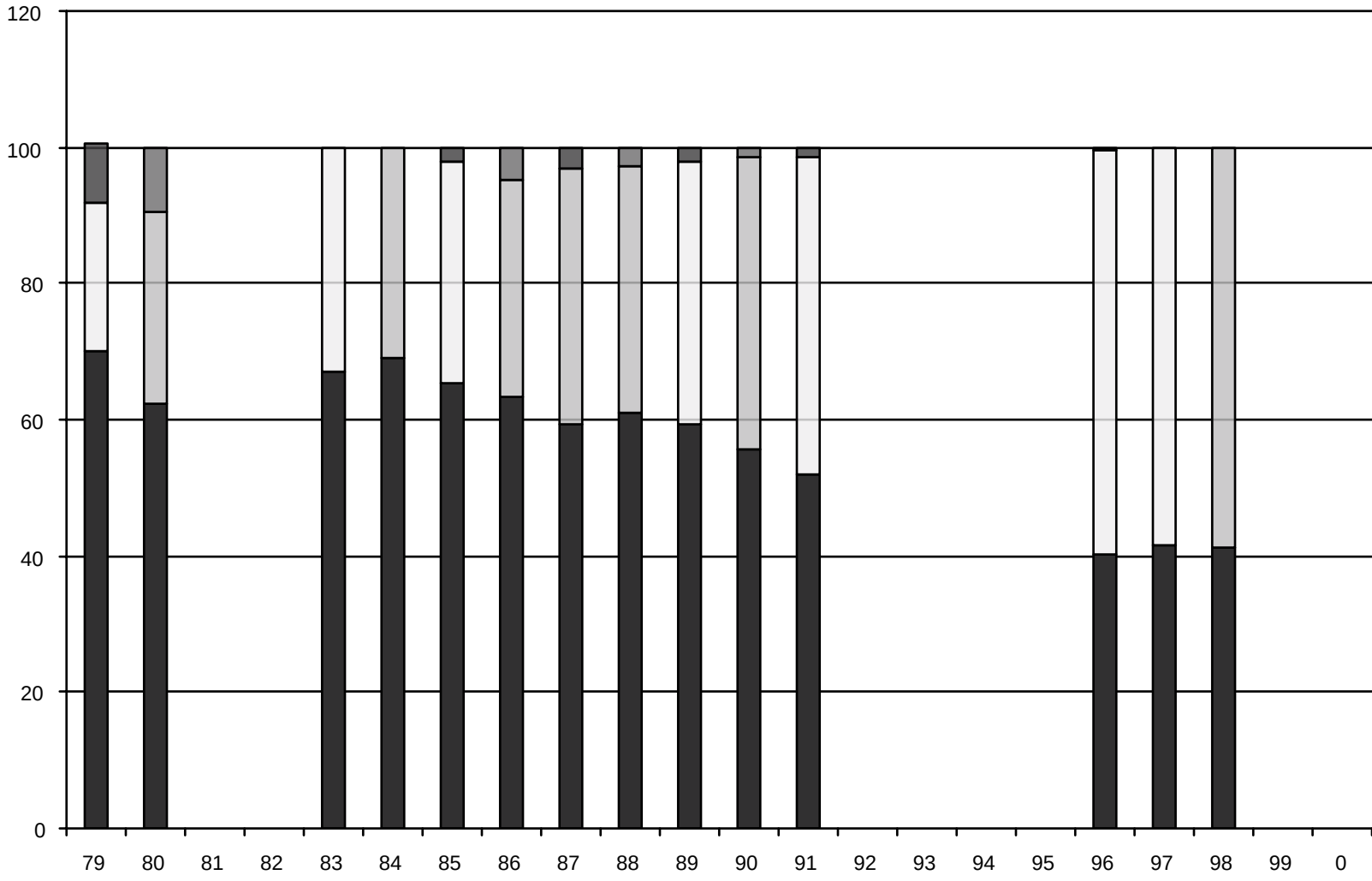

Figure 5: Rhône-Poulenc sales by sector of activity

Figure 6

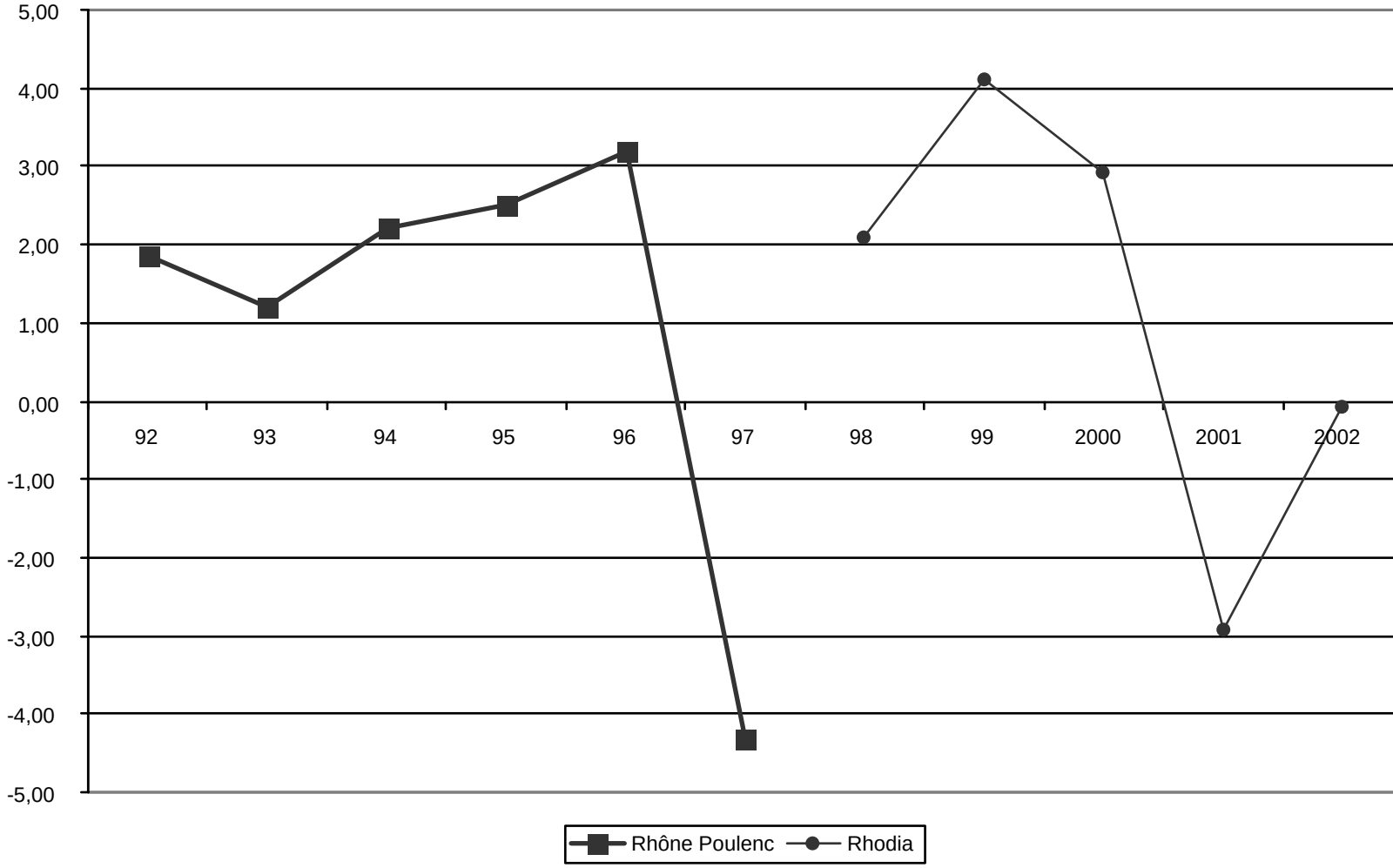

Figure 6: Comparative evolution of Rhône-Poulenc and Rhodia net income as a pourcentage of sales during the 1990s

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